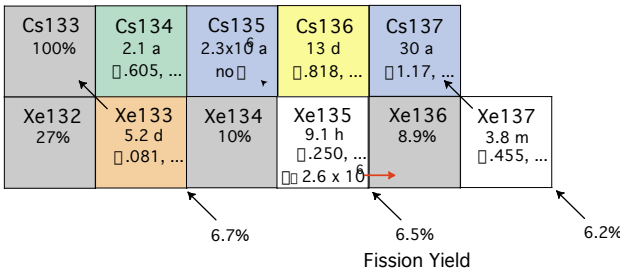
Ultrasensitive Detection Using an Optical Trap

D. J. Vieira, M.D. Di Rosa, X. Zhao
S.G. Crane, M. Hausmann, and J. Wu

- Near resonant absorption (high selectivity)
- 10^7 "scattered" photons / sec / atom (high sensitivity)
  - single atoms have been detected in a MOT

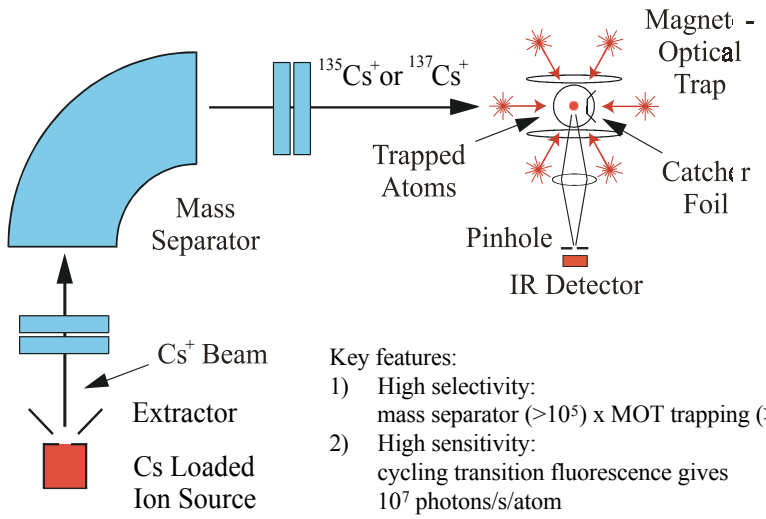
Application: trace isotope determination is important for environmental and nonproliferation / treaty verification
- consider Cs isotopes:



Large ^{135}Xe(n,) cross section diverts yield to A=136 mass chain
- ^{135}Cs/^{137}Cs isotopic ratio in reactor fuel is sensitive to neutron fluence history

Optical traps have the potential of achieving much greater sensitivities
- 100x better than existing techniques (TIMS, AMS, RIMS) depending on ^{A}Z

Ultra-Sensitive Detection Using an Optical Trap Coupled to a Mass Separator



Key features:
1) High selectivity:
   mass separator (>10^5) x MOT trapping (>10^7)
2) High sensitivity:
   cycling transition fluorescence gives
   10^7 photons/s/atom

Presenter: David Vieira

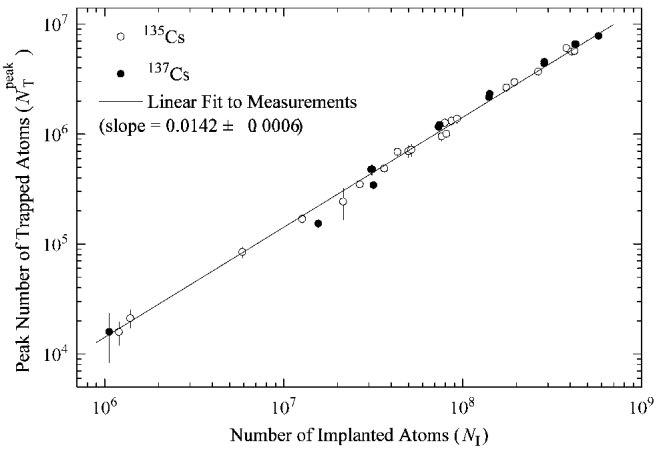


Figure 9

Di Rosa *et al.* Appl. Phys. B (in press)

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Summary & Outlook

- We have demonstrated the measurement of ^{135}Cs/^{137}Cs at ultrasensitive detection levels.
  - 4,000 atom detected / overall efficiency = 0.5%
    1 million atoms per sample
  - linear over 3 orders of magnitude with an isotope ratio accuracy of better than 10%
  - high selectivity achieved by combining mass separator & optical trap (>10^{12} suppress of ^{133}Cs relative to ^{135,137}Cs
- This method can be future improved & extended to other species
  - reduce implantation foil "memory"
  - increase detection sensitivity to the few atom level
  - Sr and Kr radioactive isotopes
- **Real world applications**
  - **nonproliferation, threat reduction and the environment**

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